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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

U.S. Application No 10/506,412 (conf 8468)
Filed 25 July 2005 Art Unit 1762
Applicants: Smith et al. Examiner: Fredrick J. Parker
For: FUEL CELL MEMBRANES AND CATALYTIC LAYERS

(corrected) Amendment in Response to Office Action of 24 April 2006

Commisssioner for Patents
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Sir:

This is in response to the Office Actions dated 24 April 2006 and 6 June 2006.

Please cancel Claims 1-32 as currently on file and replace them with new claims 33-44 presented herewith as appendix A. Per communication of 6 June 2006, Claim 33 is designated as "(new)", and new Claim 44 is made dependent from Claim 43.

Replacement paragraphs intended to obviate the informalities in the Specification are attached hereto as appendix B.

The invention, as currently claimed, describes a method, and apparatus for effecting the method, in which, in a single gas stream (a single continuous process), catalyst is deposited on the surface of support particles to produce supported catalyst, the supported catalyst is mixed with polymer, and the mixture is deposited on a substrate. The claimed method and apparatus is not obvious over Singer (US4177159) in view of Kemp (US3857737) or further in view of Hunt et al. (US6132653).

It is respectfully submitted that the Examiner is misapplying *in re Tatincloux 108 USPQ 125* (Paragraph 11 of the Examiner's action) to the method of the present invention. The continuous gas stream method of forming a catalytic layer of the present invention does not merely involve combining sequential operations into a simultaneous operation, e.g., the operation of Kemp and the operation of Singer, or for that matter, the operation of Hunt et al.

The Singer process teaches mixing polymer and supported catalyst in a blender. Then the particles (at least the PTFE particles) are broken up in either a Jet-O-Mizer (Col. 3, lines 32+) or a Waring Blender (Col. 4, lines 41+). Even if Singer were to use the pre-formed supported catalyst of Kemp, the Singer process still requires both an initial blending step that is not performed in a gas stream that leads to deposition, and a fragmentation step

(gas stream or non-gas stream), neither of which the much more efficient process of the present invention requires.

Moreover, there is no way that the cumbersome, multi-step process for producing supported catalyst in Kemp et al. could be performed within a continuous gas stream as is the case with the present invention. This multi-step, non-gas stream process is described in the paragraph Col. 1 line 56-Col. 2, line 3:

> "In further accord with the invention, a fuel cell electrode catalyst comprising crystals of a noble metal fuel cell catalyst specie deposited on particles of an inert carrier or support powder is prepared by (a) mixing a slurry of inert carrier powder and a solution of a salt of the fuel cell catalyst specie, (b) concentrating and drying the solution, (c) decomposing the platinum salt to form a partial product powder of less than a desired concentration of small catalyst crystals adhered to the inert carrier particles, (d) mixing a slurry of said partial product powder and a solution of a salt of said fuel cell catalyst, (e) repeating step (b), (f) decomposing the salt to form a powder of a higher concentration of catalyst, and (g) repeating steps (d)-(f) as necessary to form a final product powder of a desired concentration of catalyst on carrier particles."

It should be noted that none of the steps of forming the supported catalyst in Kemp et al. are performed in a gas stream. Furthermore, the entire Kemp et al. process takes many hours to complete, particularly because a single processing of the support material with the catalyst precursor does not provide sufficient catalyst loading. This requires multiple repeats of the process. Four repeats of the process are required in the process described in the Example from Col. 2, line 43-Col. 3., line 23. By applicants' calculation, this Example took at least 22 hours to perform and thereby produce the supported catalyst. In contrast, in applicants' process, formation of the supported catalyst takes place in a matter of seconds, and the whole process, from initial introduction of support particulates to deposition of the catalytic layer, take place in under a minute, generally far less than a minute.

It is inherent in Applicants' process that all of the catalyst will deposit on the surface of the support and thereby be available for catalytic activity. On the other hand, in Kemp et al., the process must be repeated several times to achieve the desired catalytic loading. In each repeat, the support and the precursor of the catalyst are mixed, dried into a cake, and the cake then ground. It must be presumed that in each step, a certain amount of the catalyst becomes buried within the particles that are produced, making that portion of the catalyst unavailable for catalytic activity. As catalytic metals tend to be expensive, the processes of the present invention inherently produces a supported catalyst with higher catalytic activity relative to amount of catalyst used.

While the Kemp et al. example added 5 wt% catalyst relative to support particles per cycle, i.e., two cycles to achieve 10%, four to achieve their desired 20%, Applicants' process inherently requires that their desired catalyst loading on support materials occur on a single pass, as once the support/catalyst particles are admixed with the polymer, no further catalyst loading can occur. While Applicants can easily achieve 20% catalyst relative to support loading, even up to 100% (equal weight of catalyst and support), more

typically Applicants aim for somewhat greater than 10% catalyst relative to support. Because Applicants' process produces supported catalyst with very small (high surface area) catalyst particles, all of which are on the support surface, Applicants' target catalyst is typically somewhat lower than the 20% loading sought and achieved through four cycles in the Kemp et al. example. A lower target loading, of course, is more efficient use of expensive metals, particularly platinum.

Applicant's process forms the supported catalytic material, mixes it with polymer, and deposits the mixture to form a catalytic layer, all in a single, continuous gas stream process. For this reason, Claim 33, directed to a method, and Claim 40, directed to apparatus, are believed to be allowable. With regard to *in re Tatincloux 108 USPQ 125*, those claims which involved merely performing simultaneous operations that had previously been performed in sequence were not deemed patentable, but those claims that added to the combination of the previous processes were deemed patentable. Here, the novel and non-obvious efficient process is not just simultaneous performance of prior art processes, but a continuous gas stream process that achieves or exceeds the results of the combination of the prior art processes, neither of which alone is performed entirely in a continuous gas stream.

Neither Kemp nor Singer teach a flowing gas stream in which supported catalyst is produced in a first region of higher temperature and then mixed with polymeric material in a second lower temperature region as per dependent Claim 34, and this claim is believed to be further allowable, as are Claims 35-37 depending therefrom.

The quenching means of Claims 38 (and 39) are irrelevant to Kemp and Singer and are likewise believed further allowable.

Regarding Claims 34-37, Hunt et al. teach deposition of materials as layers on substrates, but not material on gas-carried particulates. Thus, these claims distinguish over Hunt et al.

For similar reasons claims depending from apparatus Claim 40 are believed to be further allowable.

It is believed all of the claims are currently in condition for allowance; favorable action is courteously requested.

12 June 2006

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